

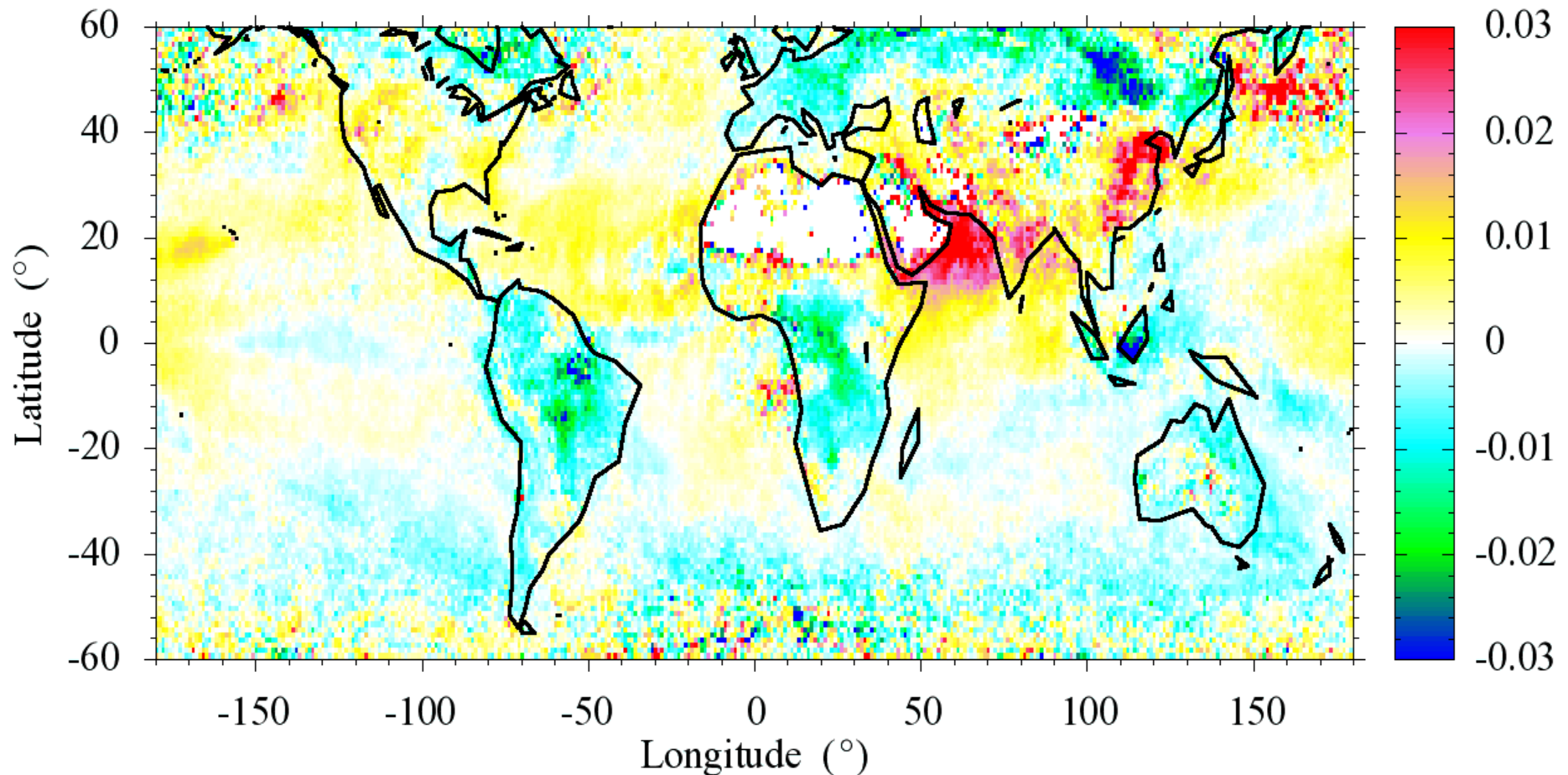
SHORT-TERM AEROSOL TRENDS: REALITY OR MYTH?

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Spatial Distribution of AOT (Terra) Annual Anomaly Trend (Time range Sep 2002 – Aug 2008)

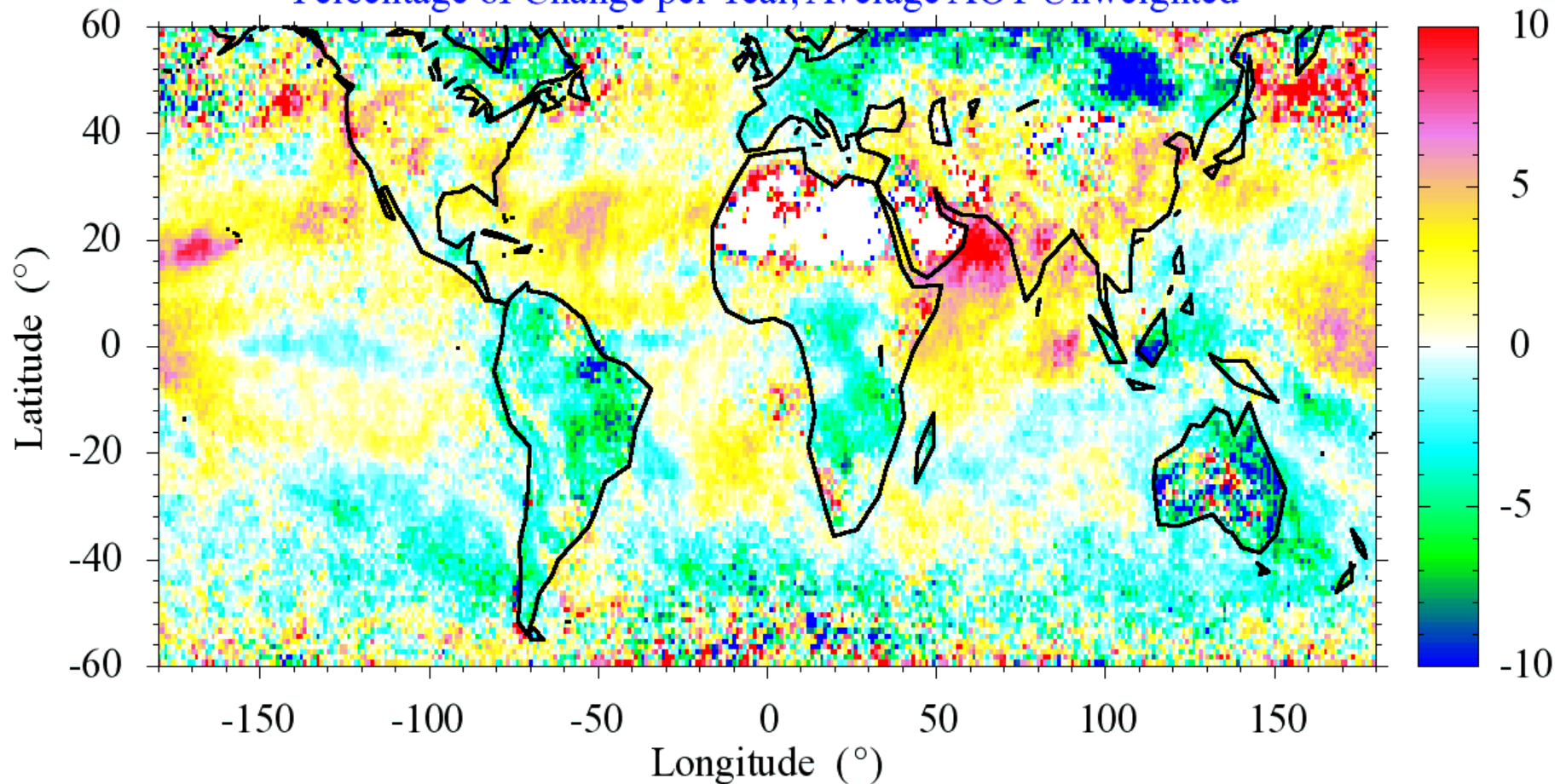


Annual Anomaly: Deviation of monthly AOT time-series in each 1 x 1 grid (72 points for 6 years)
from the AOT averaged over 6 years

Least squares linear trend: slopes (per year) for each grid box

Spatial Distribution of AOT (Terra) Anomaly Percentage Change per Year

Percentage of Change per Year, Average AOT Unweighted



Main questions addressed

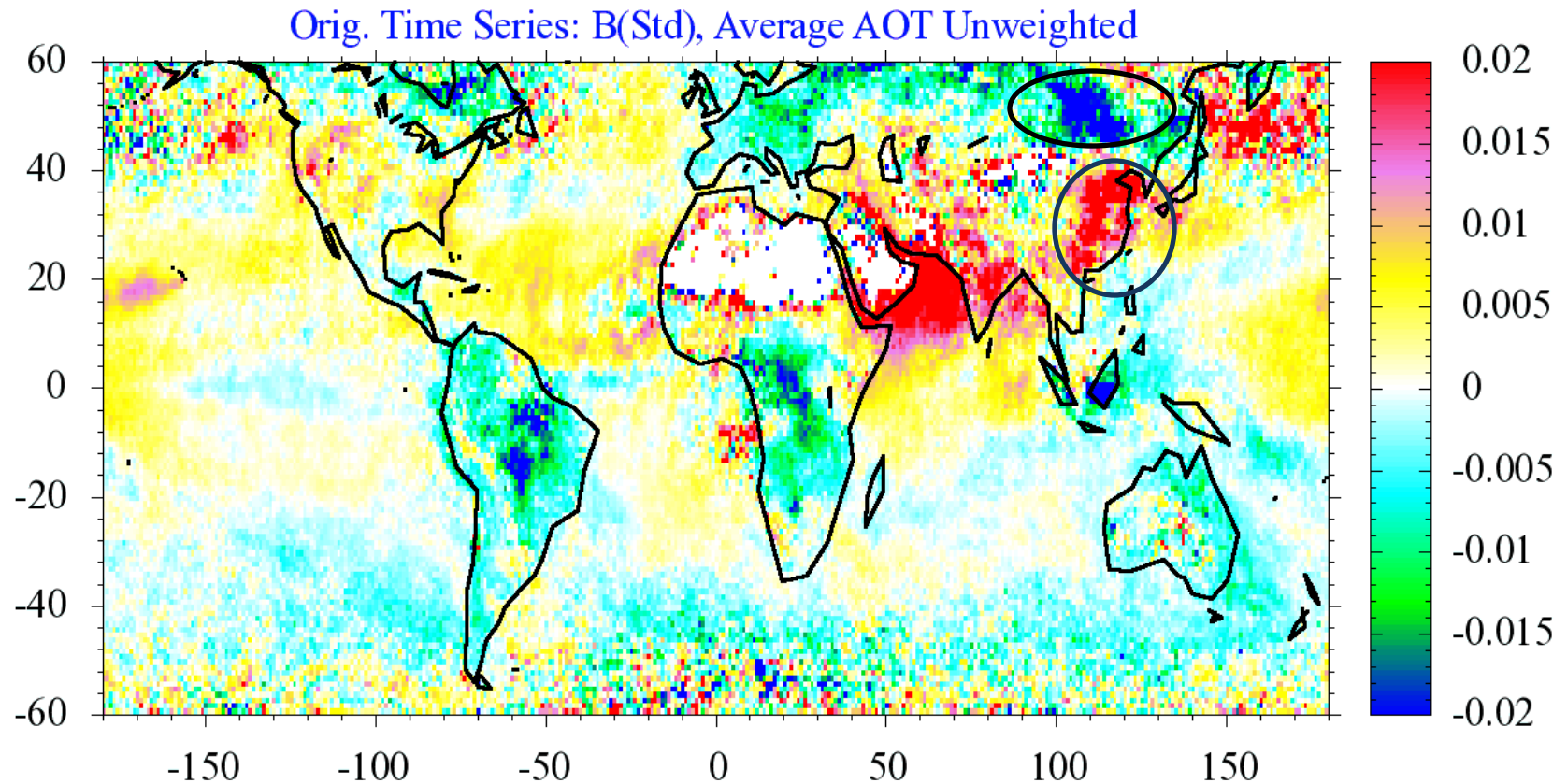
Short-term Trends of MODIS AOT over six years

- Why are the trends different in different regions?
- How these trends be so high?
- Why are they “coherent” in many areas?
- Are these changes in aerosol concentrations real, i.e., are they monotonic changes in emissions?

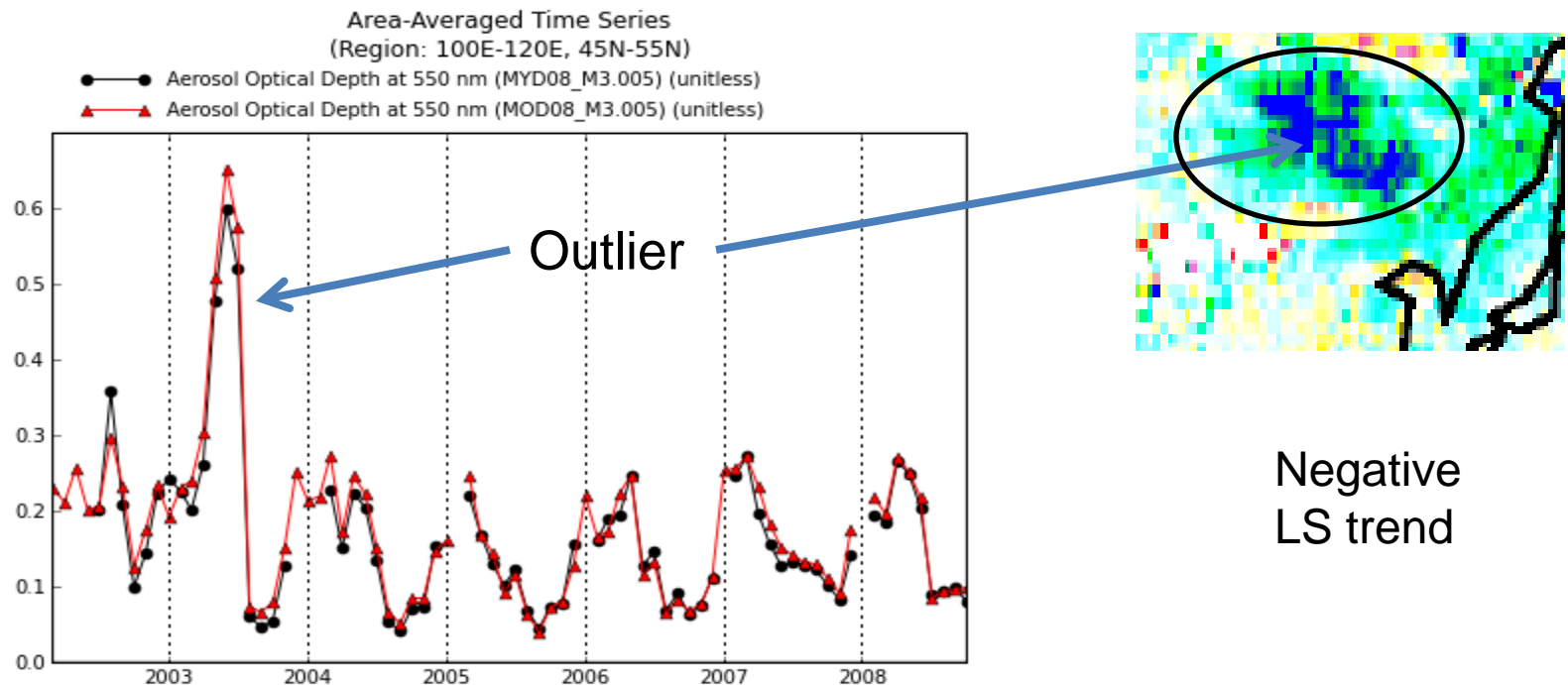
Possible alternative explanations

- **Trend computation artifact?**
- Need a better deseasonalization?
- Related to changes in meteorology patterns?

MODIS Terra AOT Anomaly Trend (Least Squares)

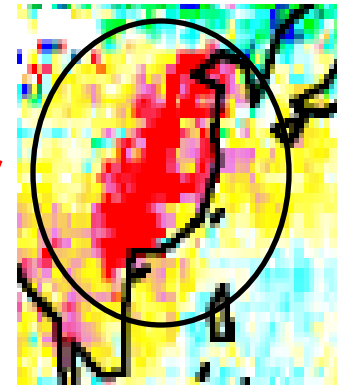
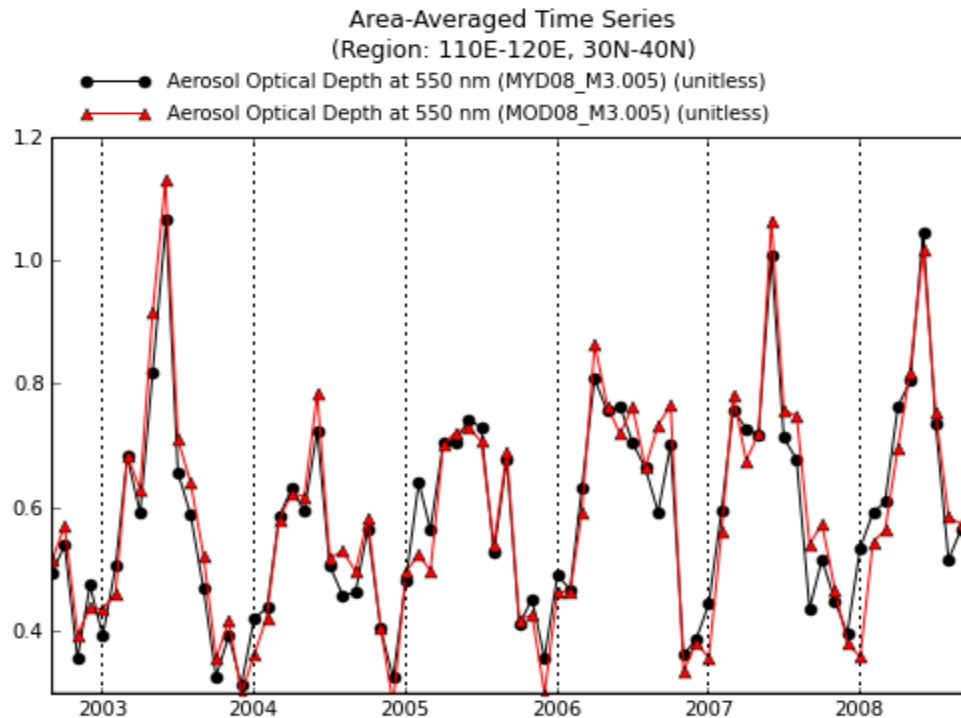


2003 Siberian Fires and “negative” AOT trend

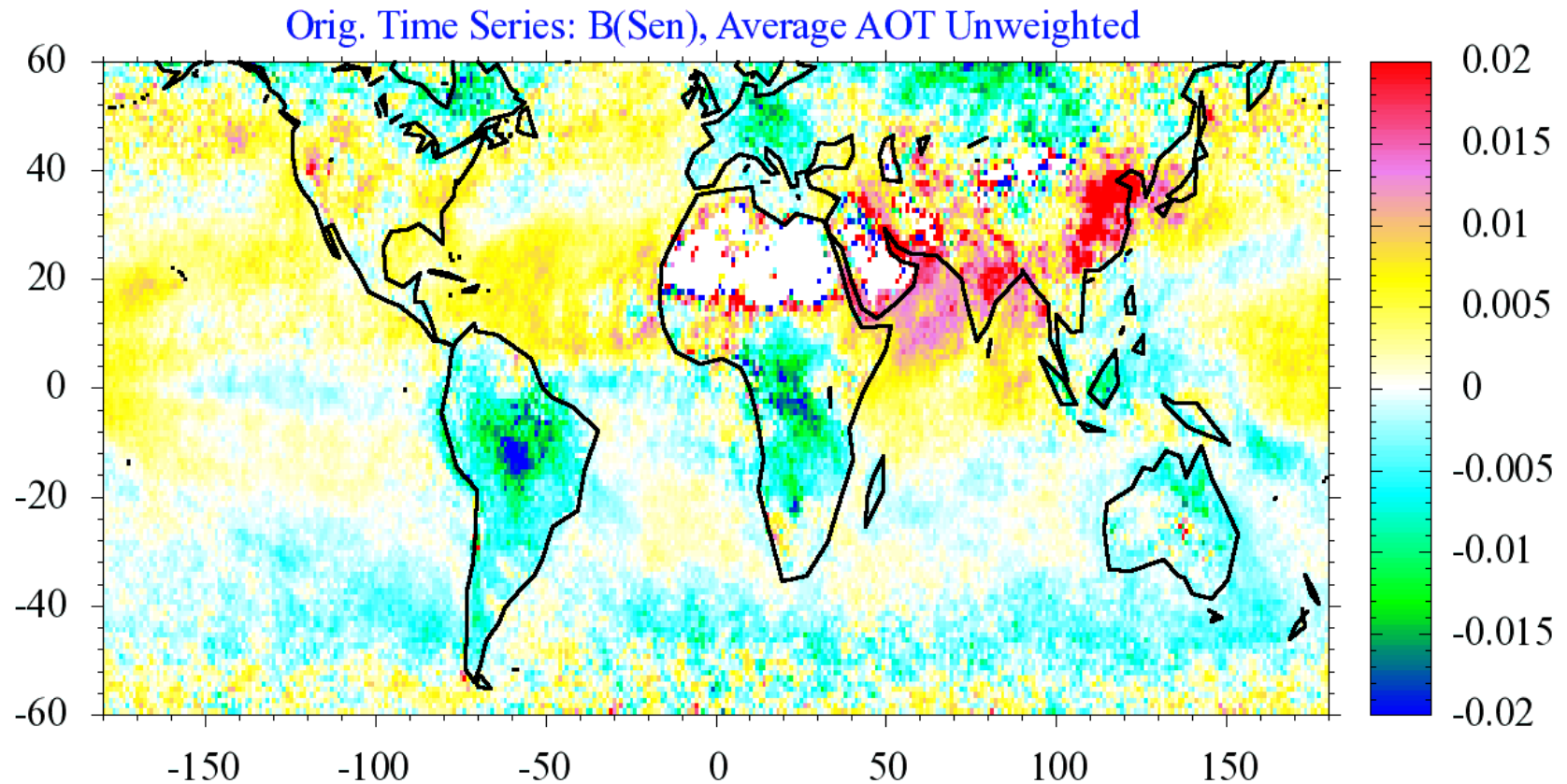


The regular Least Squares (LS) linear trend is simple but sensitive to outliers
An alternative (Sen) linear trend is less sensitive to outliers

Eastern China: real positive trend



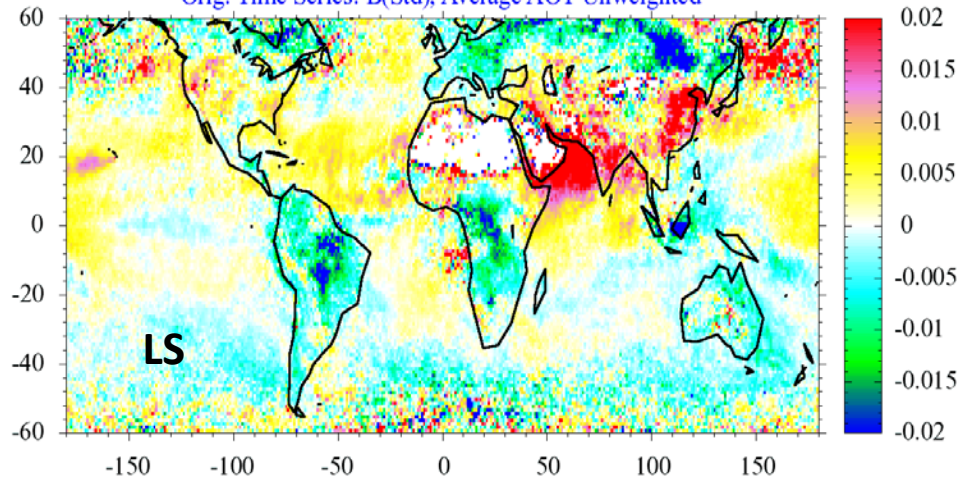
MODIS Terra AOT Anomaly Trend Alternative (Sen) computation



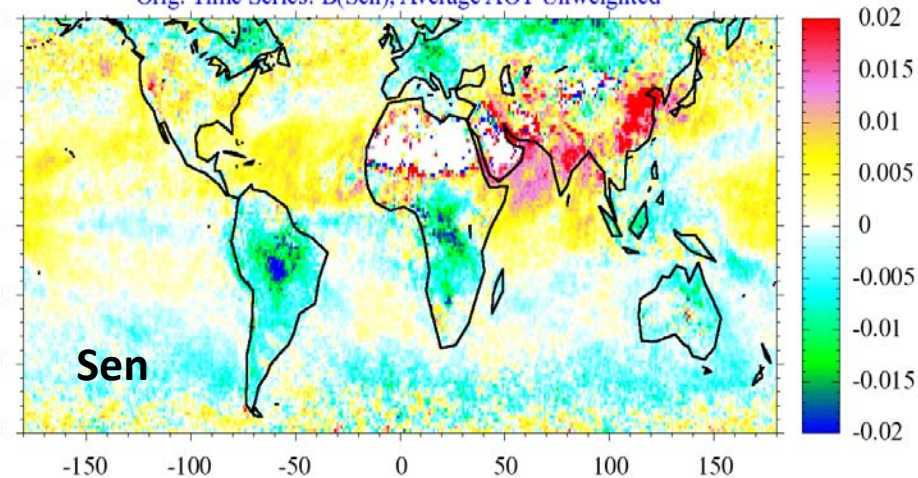
An alternative linear trend based on Kendall-Sen non-parametric statistics is more robust and less sensitive to outliers

MODIS Terra AOT Anomaly Trends: Difference between LS and Alternative (Sen)

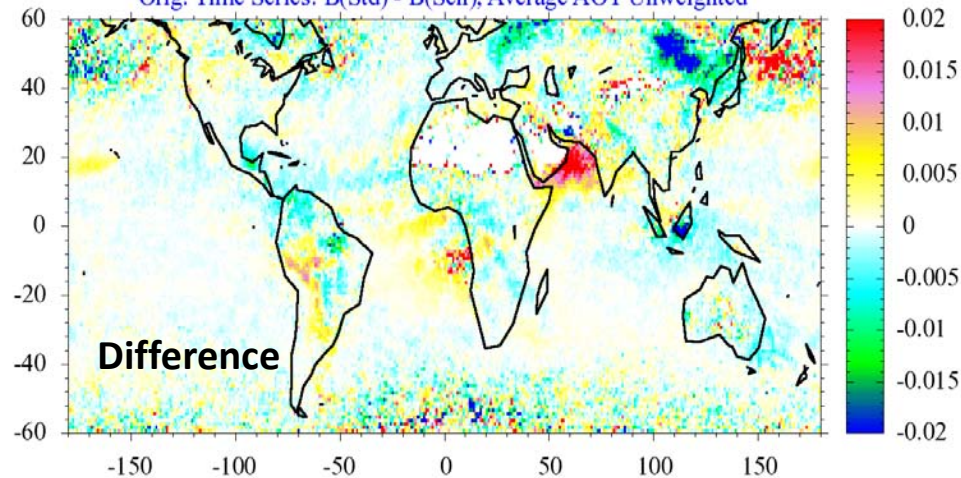
Orig. Time Series: B(Std), Average AOT Unweighted



Orig. Time Series: B(Sen), Average AOT Unweighted

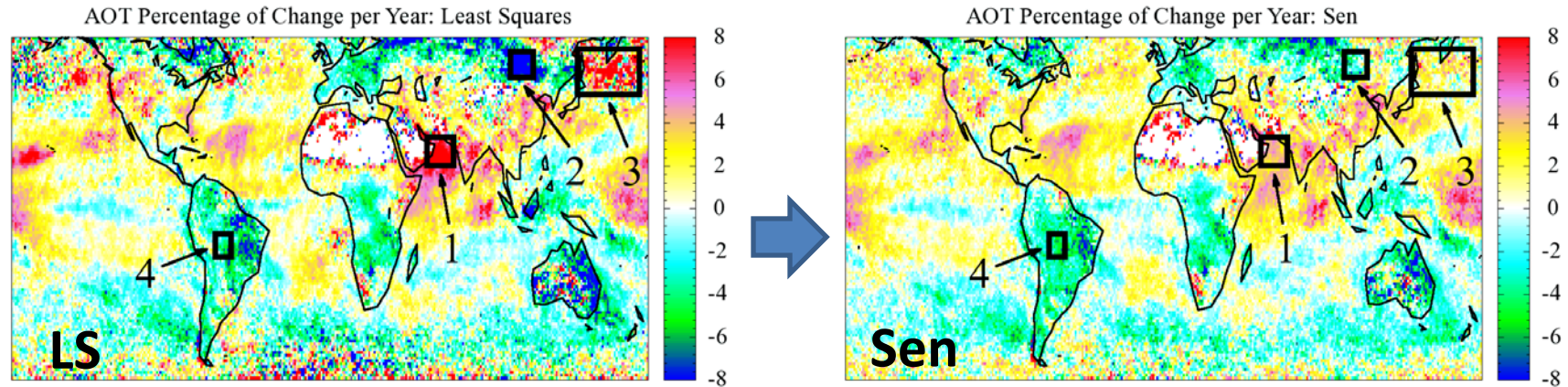


Orig. Time Series: B(Std) - B(Sen), Average AOT Unweighted

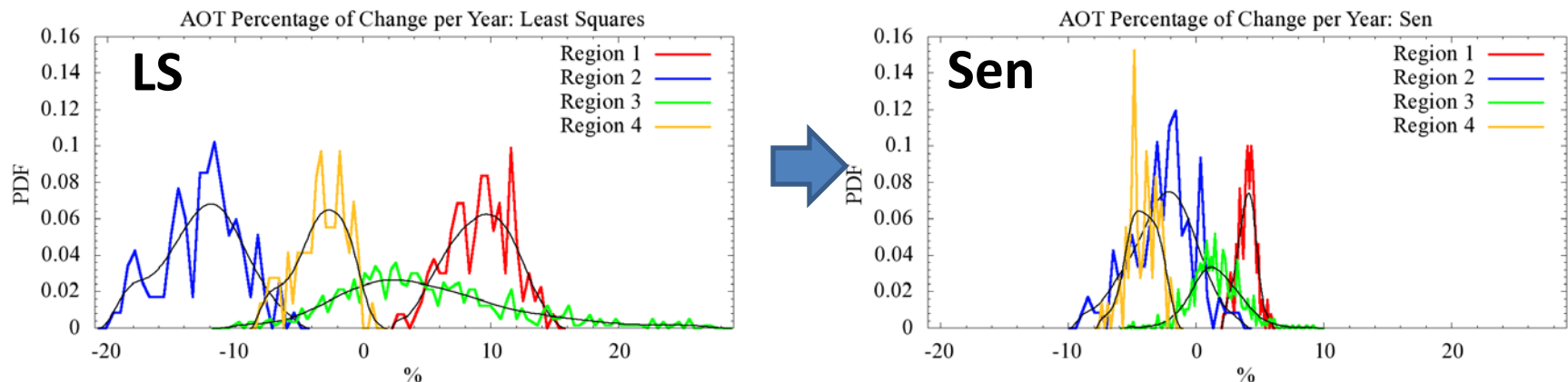


Characteristics of outlier hot and cold spots

MODIS Terra AOT Percentage of change per year



PDFs for four case study regions (Bezier approximations are shown in black)

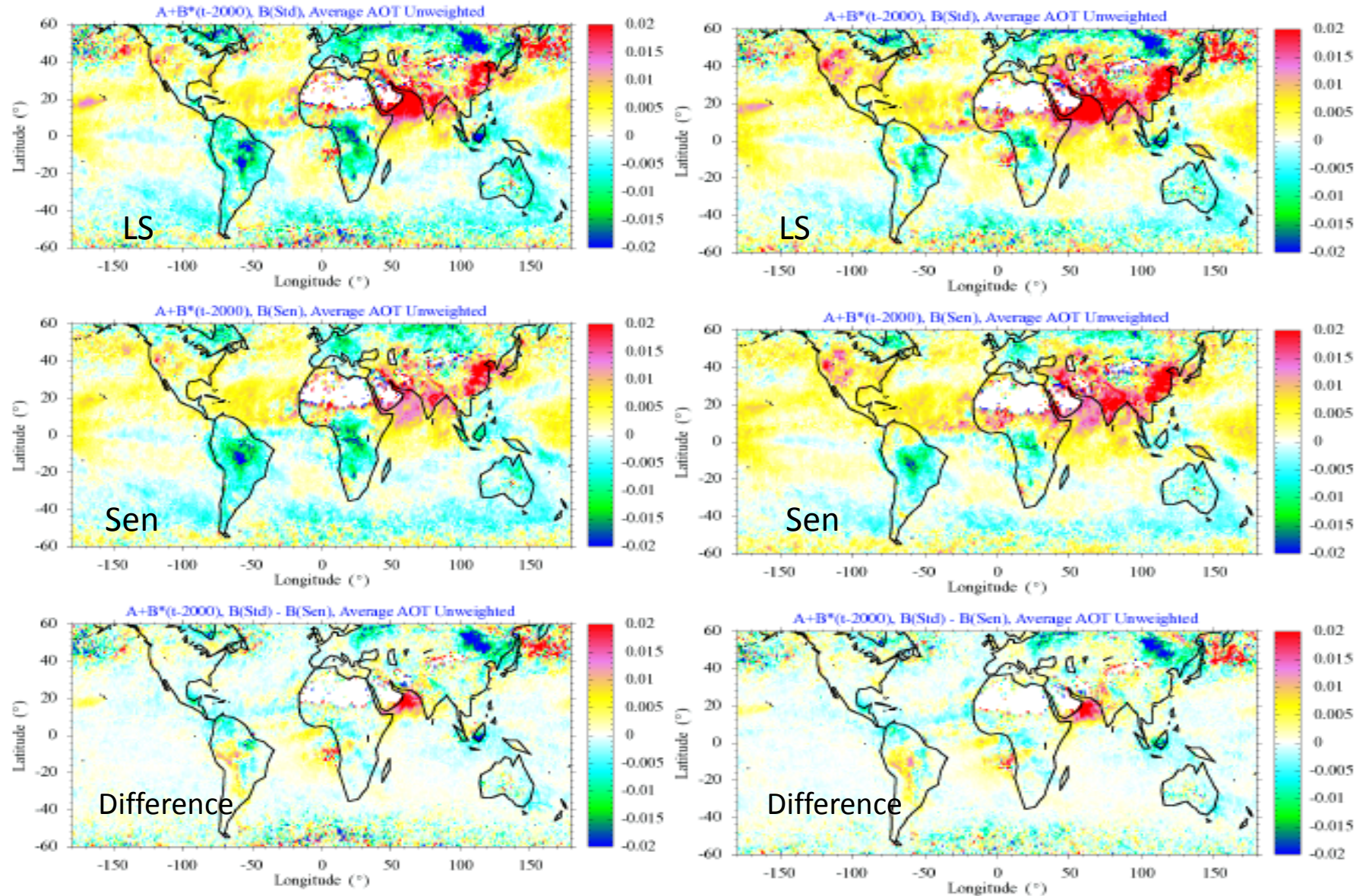


Sen shrinks outliers' PDFs and pushes them closer to zero

Possible alternative explanations

- Trend computation artifact?
- **Need a better deseasonalization?**
- Related to changes in meteorology patterns?

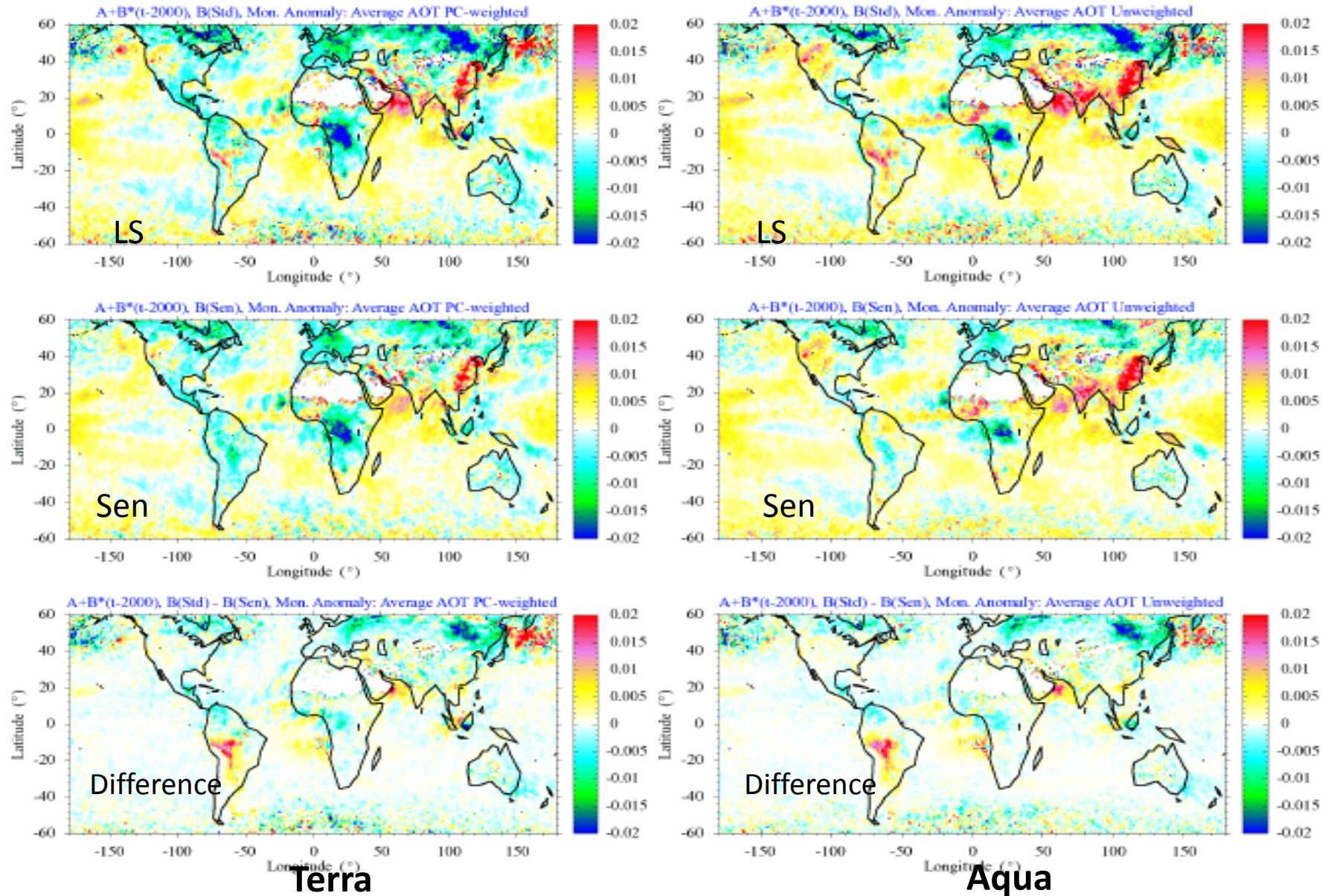
MODIS AOT Annual Anomaly Linear Trends



Terra

Aqua

Deseasonalized AOT Monthly Linear Trends

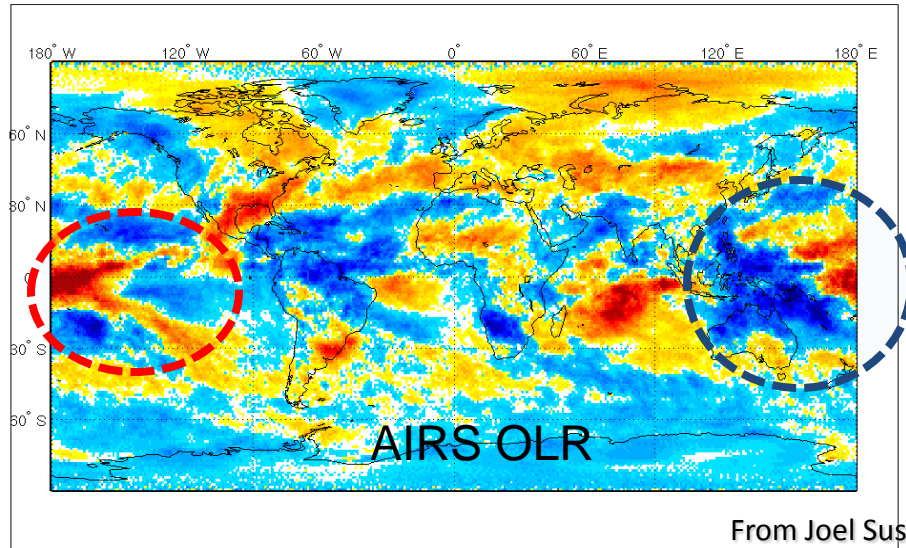


Possible alternative explanations of AOT short-term changes in some areas

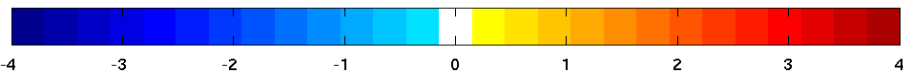
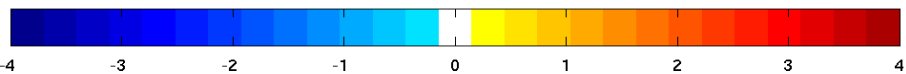
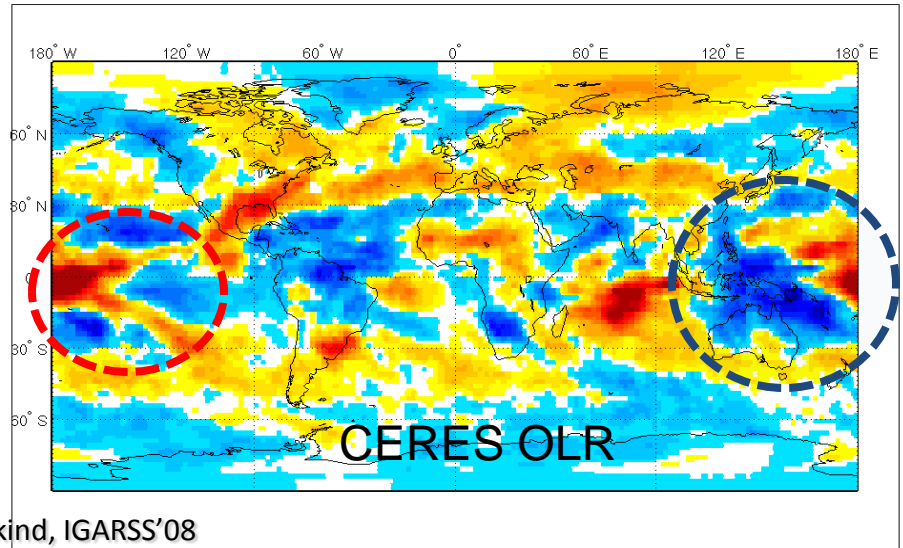
- Trend computation artifact?
- May disappear after deseasonalization?
- **Related to changes in meteorology patterns?**

Similarities in MODIS Cloud Properties Anomaly trends with the Coincident 52-Months of CERES and AIRS-V5 OLR

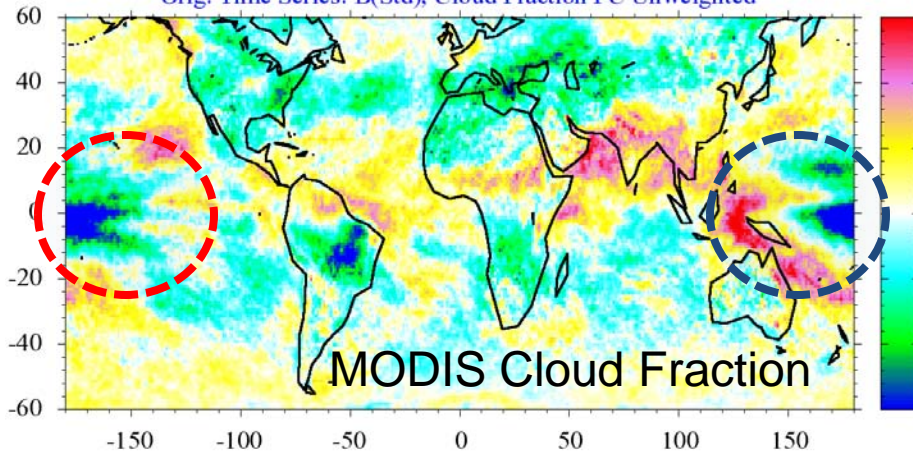
Sep./02-Dec./06 AIRS-V5 All-Sky OLR Anomaly "Trend" [$\text{W/m}^2/\text{yr}$]



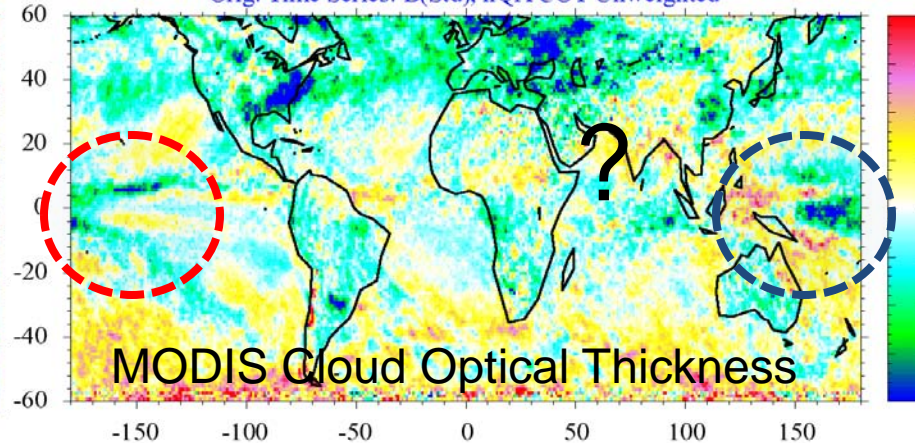
Sep./02-Dec./06 CERES All-Sky OLR Anomaly "Trend" [$\text{W/m}^2/\text{yr}$]



Orig. Time Series: B(Std), Cloud Fraction PC Unweighted

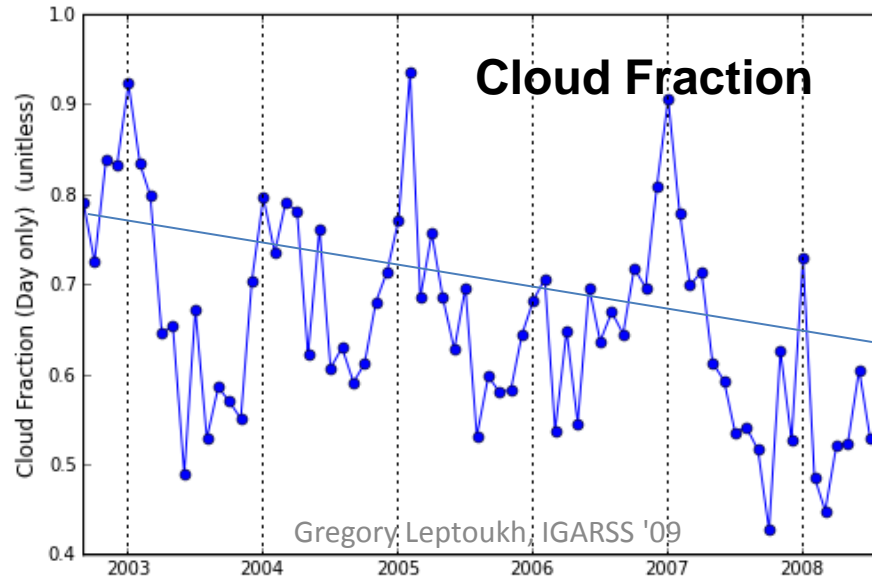
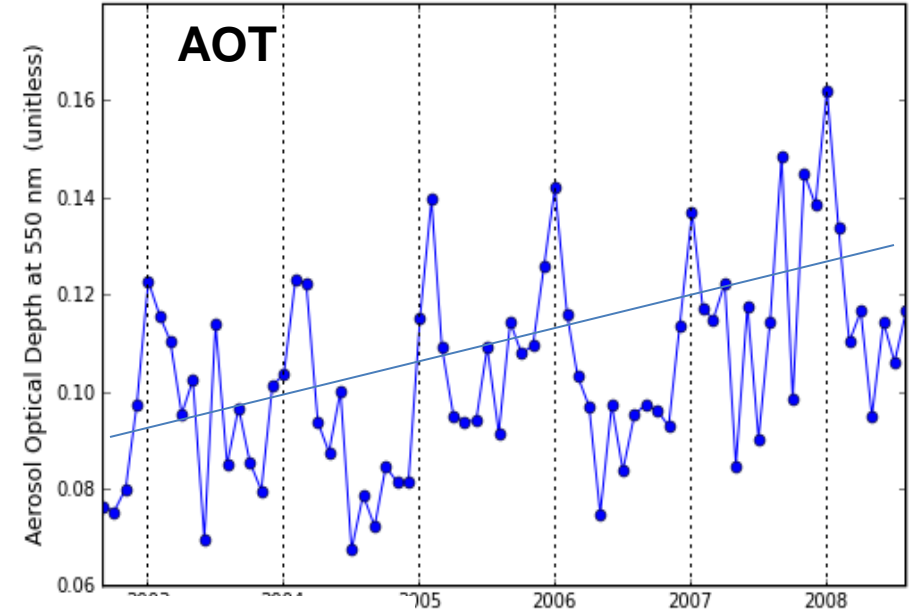


Orig. Time Series: B(Std), nQA COT Unweighted

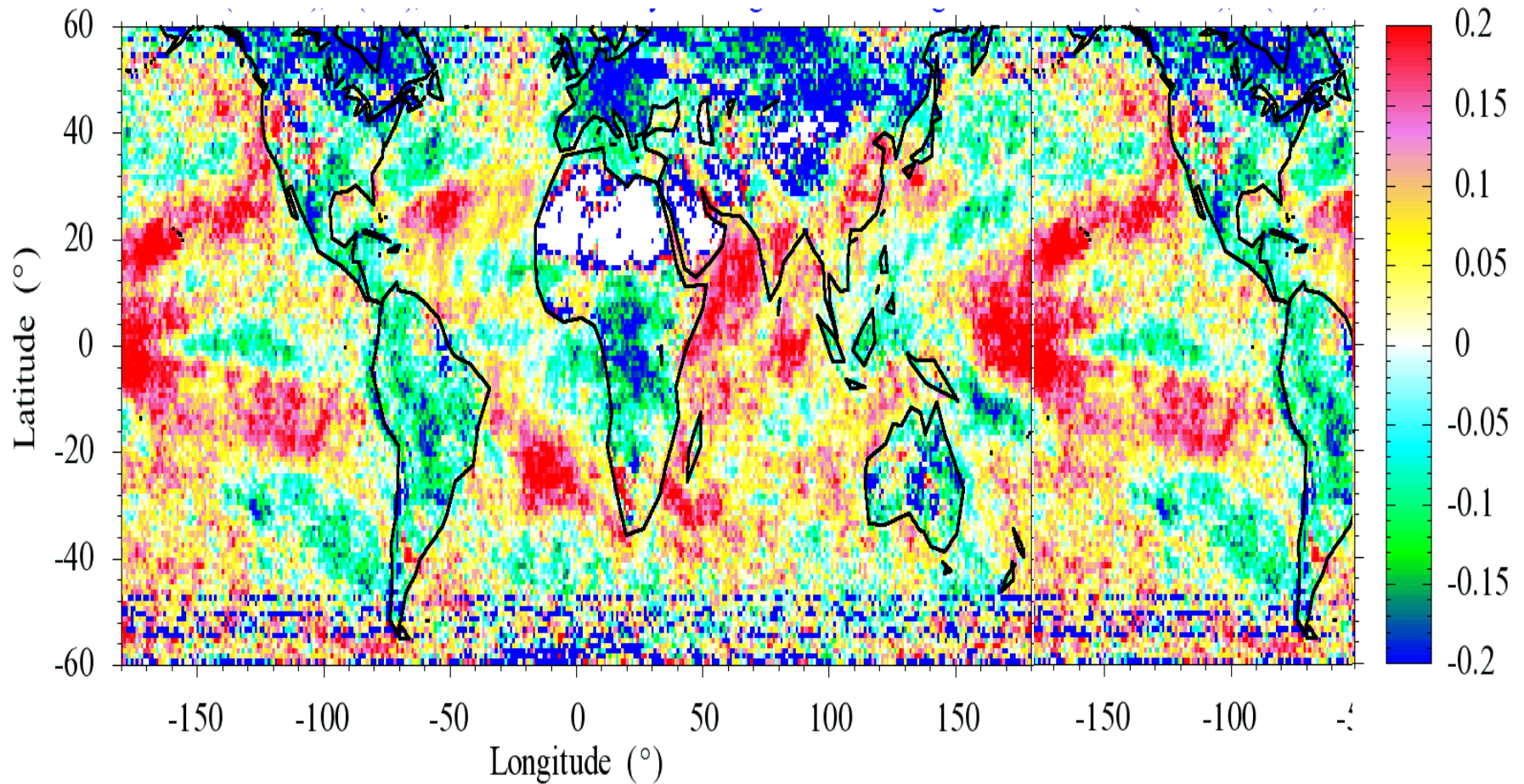


Western Pacific Warm Pool displacement (5S-5N, 160E-160W)

For area (Lat: 5S-5.0N, Lon: 160.0E-160W)



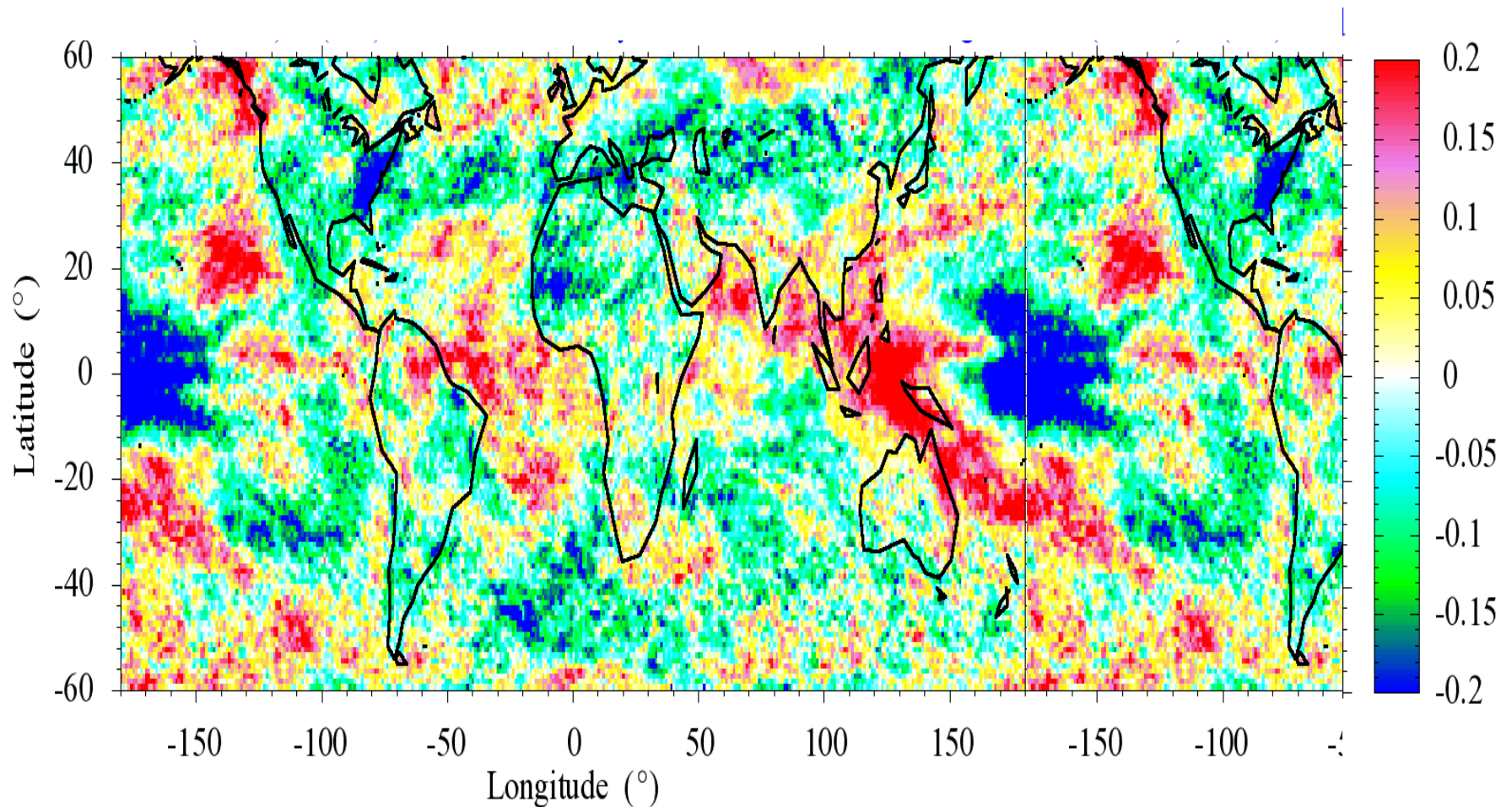
MODIS AOT *Standardized* Anomaly Trend (LS)



Standardized or normalized anomaly: divided by anomaly std

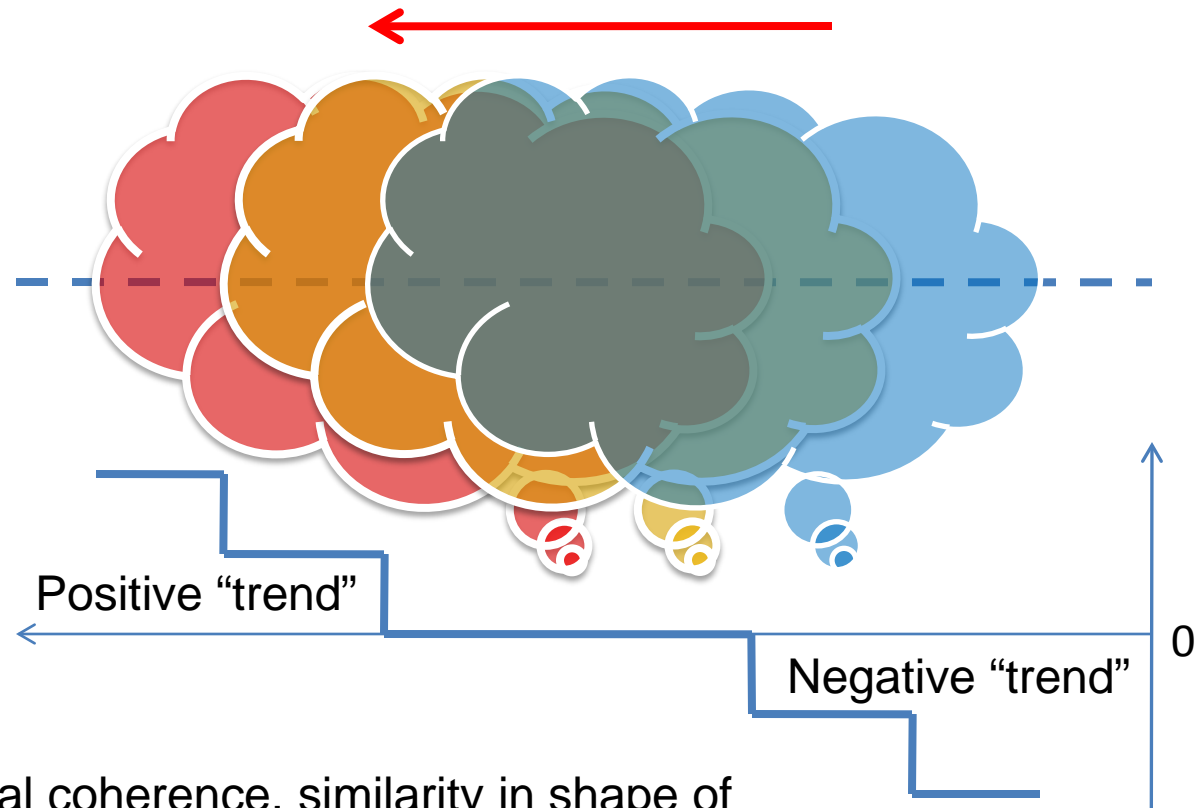
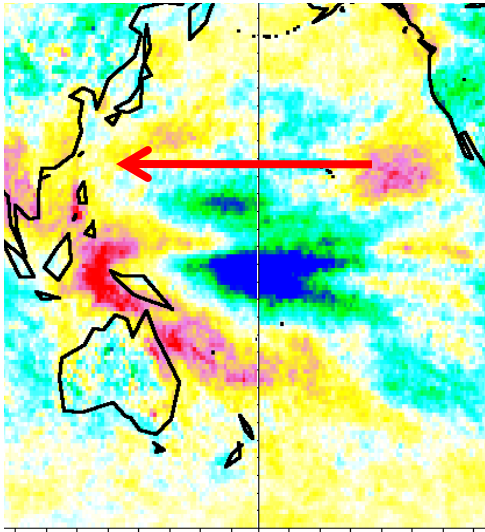
MODIS Cloud Fraction *Standardized* Anomaly Trend

Western Pacific Warm Pool case



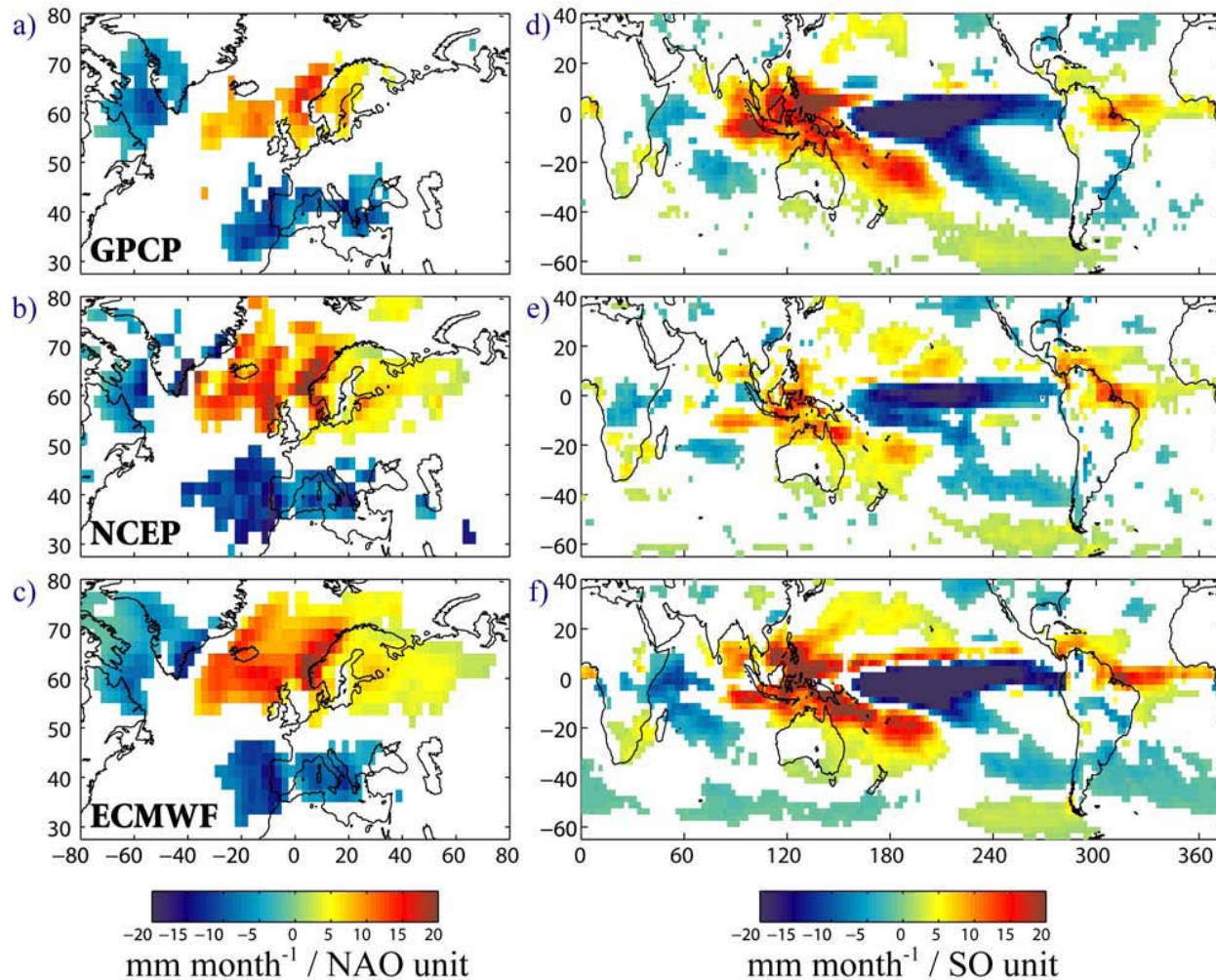
Western Pacific Warm Pool contraction → cloud pattern displacement

Displacement leads to artificial trend



This explains spatial coherence, similarity in shape of adjacent areas with opposite trends, and magnitude of trend

NAO and SO cause precipitation trends



From: Kyte, E.A., G.D. Quartly, M.A. Srokosz and M.N. Tsimplis, 2006, 'Interannual variations in precipitation: The effect of the North Atlantic and Southern Oscillations as seen in a satellite precipitation data set and in models', J. Geophys. Res., 111, art. no. D24113

Conclusions (trends)

- There is a broad spatial inhomogeneity in AOT trends over 6 years of MODIS Terra and Aqua
- Some of the areas demonstrate clear positive trends related to increase of emission (e.g., Eastern China)
- Strong trends in some other areas are superficial and might be attributed, in part, to:
 - **Least squares linear trend sensitivity to outliers (need to use more robust linear fitting method)**
 - **Spatial and temporal shifts or trends in meteorological conditions, especially in wind patterns responsible for aerosol transport**
- Aerosol trends should be studied together with changes in meteorology patterns as they might closely linked together